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Hamilton-Wentworth. Dept of  
Engineering  
L Hydrogeological aspects of  
proposed Glenbrook landfill  
sites





# Gartner Lee Associates Limited

Hamilton -  
Wentworth  
Dept. of  
Engineering

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Consulting  
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December 21st, 1978

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The Department of Engineering,  
The Regional Municipality of Hamilton-Wentworth,  
City Hall,  
Hamilton, Ontario.

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Attention: Mr. W. Wheten, P.Eng.,  
Commissioner of Engineering

Dear Sir:

Re: Additional Discussion - Hydrogeological Aspects  
Proposed Glanbrook Landfill Site  
Addendum to Final Report 76-49 (June, 1978)

The Ministry of the Environment has now reviewed the above noted report and based on our discussions with them we are pleased to supply the following notes as points of clarification and comment. Most of the aspects were brought out and explained in the recent O.M.B. Hearing. As well, some of the discussion is provided for the benefit of the non-technical reader. This addendum is then intended for enclosure with our final report 76-49. Details are as follows.

We understand that the Ministry staff who reviewed the report concur overall with the report and that the conclusions and recommendations are valid. Therefore, the subject site, if properly engineered and operated as proposed, is suitable, acceptable and safe.

As stated in our June report the clay materials above the water table are subject to wetting-drying, freeze-thaw cycles. This results in cracking of these clays above the zone of saturation that creates a fracture or secondary permeability and porosity. The clay soils have an intergranular pore space or porosity of 40%±. However, because of the clay mineral nature of the soil, the

continued -



specific yield or water that drains out is very small, often in the range of 5%. As well, the fractures of the clay are considered comparable to joint and structure porosity of a bedded rock i.e. shale or limestone, and this is also usually on the average about 5% (range of 1 to 10%). Therefore, if the effective pore space or openings are in the range of 5%, an infiltration of 3 inches of water from precipitation would result in an average five foot water table fluctuation seasonally in areas of recharge. It should also be remembered that silty clay soils have a fairly high capillary fringe, i.e., moisture contents close to field capacity in the recharge areas, in which small amounts of infiltration result in fairly large water table fluctuations.

As well as secondary porosity, the clays above the water table have a secondary or fracture permeability, i.e. water transmission ability. Clays below the water table are very slowly permeable, i.e.,  $10^{-7}$  to  $10^{-8}$  cm/sec. The zone in which the water table fluctuates is in the secondary permeability clay material. If one considers that the high spring water table dissipates often within 60 to 90 days, this water then migrates laterally via the fractures to the zone of discharge. As a result the effective permeability is that of sand-silt material, i.e.,  $10^{-3}$  to  $10^{-4}$  cm/sec. This neglects the capillary fringe mentioned earlier. For this reason we have recommended leachate collection in which hydraulic gradients are to the collector at the perimeter of the fill. Since the water table is lower at the collector no leachate can migrate from the fill in this fracture zone.

In measuring the hydraulic head in the installation that flowed under artesian head, i.e., BH9, an additional riser pipe was added to get an exact measurement. In July and August the pipe was vandalized and broken and thus an exact head could not be measured. An observation was made i.e., that it was a "flowing head" only. In plotting the hydrograph you will note a lack of points for BH9 (Figure 6) in this period and the curve is simply extrapolated. Therefore, there is no error in the data.

In the excavation of the cells, the walls and floors of the cut will be examined. As the M.O.E. agrees, we expect uniform soil conditions. In the event that an anomalous zone is encountered, e.g. a sand seam, then a competent soils engineer or hydrogeologist should be contacted. The sealing of such a zone is a routine over-



excavation - clay backfill operation. Since the operation requires excavation below the water table, inflow of ground water will occur. However, if one considers the low specific yield, low permeabilities and hydraulic gradients, this amount is small and easily handled with the cell. Observations of the first cells can be used to confirm this and estimate the rate of inflow.

The source of water for drilled wells and thus the main aquifer zone of the area are the discontinuous sands just above the rock, beneath the clays, and the upper zone of the rock itself. This sand-rock zone appears hydraulically connected, under sub-artesian head and sealed from surface by the clays. Some wells in the area have been drilled to depth indicating that the aquifer can be of low transmissibility and yield locally. Although the Guelph-Lockport dolomite is overall or regionally excellent as an aquifer, it obviously has local tight zones. As some of the public stated in the O.M.B. Hearing, the water quality at depth in the rock often became sulphurous as well. Comparisons with other areas are relative but it is the best source in this area.

We understand that surface water quality is not well documented in the basin. Due to the cost involved, background water chemistry is recommended as part of the monitoring system, if the site is approved. Such costs involved in establishing baseline chemistry before approval in our opinion do not seem practical. In any event, the site is designed for leachate collection and isolation from the Welland River and its tributaries. Monitoring is a recommended part of the scheme. The area to be landfilled is a minor fraction of a single percent of the Welland River drainage basin. Because of the clay sub-soils, base flow contribution in the subject area of the basin, i.e. discharge of ground water to surface, is very minor over short distances because of the low permeability of the clays, i.e.,  $10^{-7}$  to  $10^{-8}$  cm/sec, about 0.1 ft/year. We would suspect that the construction of the conservation dam upstream and regulation of flow was used to improve the natural setting. Therefore, the base flow over short distances is insignificant.



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The Welland River receives run-off from urban and agricultural areas and is utilized for a number of uses ranging from waste assimilation to livestock watering.

As we agreed, actual evapotranspiration rates can be lower than potential depending on the soil moisture regime, ranging from  $20" \pm$  to  $24" \pm$ . The M.O.E. agree with our infiltration rates on the fill in both the short and long-term.

Other items discussed are generally those of an operational nature and will be dealt with by Proctor and Redfern Limited.

Respectfully submitted,

GARTNER LEE ASSOCIATES LIMITED



P. K. Lee, M.A., P.Eng.,  
Consulting Engineering Geologist

PKL/sc



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